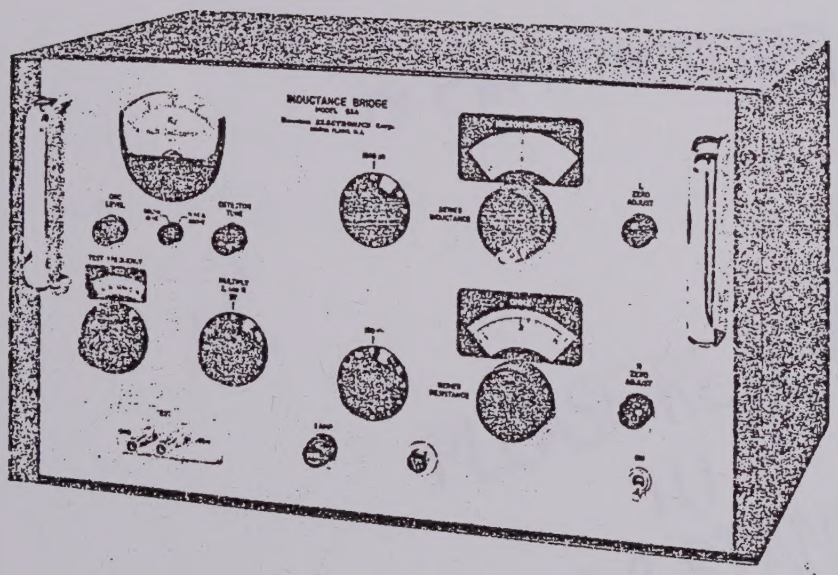
INSTRUCTION BOOK

MODEL 63A

INDUCTANCE BRIDGE



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BOONTON ELECTRONICS CORPORATION

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INSTRUCTION BOOK
MODEL 63A
INDUCTANCE BRIDGE

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SECTION I

SPECIFICATIONS

Inductance Measuring Range: .002 μh to 1.1 h in 5 steps as follows:

MULTIPLIER	INDUCTANCE RANGE	RESOLUTION OF INDUCTANCE READING
100	0 to 1.1 h	.01% + 20 μh
10	0 to 110 mh	.01% + 2 μh
1	0 to 11 mh	.01% + .2 μh
.1	0 to 1100 μh	.01% + .02 μh
.01	0 to 110 μh	.01% + .002 μh

Inductance Measuring Accuracy: $0.25\% + \frac{300}{C}\% + .002$ μh, where C is the resonating capacitance in μμf of the test inductor at the frequency of test.

Series Resistance Measuring Range: .002 ohm to 110K ohm in five ranges as follows:

MULTIPLIER	SERIES RESISTANCE RANGE	ACCURACY
100	0 to 110K ohms	$2\% + \frac{\Omega}{25}\% + 20$ ohms
10	0 to 11K ohms	$2\% + \frac{\Omega}{25}\% + 2$ ohms
1	0 to 1100 ohms	$2\% + \frac{\Omega}{25}\% + .2$ ohm
.1	0 to 110 ohms	$2\% + \frac{\Omega}{25}\% + .02$ ohm
.01	0 to 11 ohms	$2\% + \frac{\Omega}{25}\% + .002$ ohm

Frequency Range: 1 KC to 100 KC with internal oscillator and detector

Frequency Accuracy: ± 3%.

Note: The accuracy of the test frequency has negligible effect on the accuracy of the inductance measurement.

Frequency Stability: Approximately ± 1/2% after warm-up.

Tube Complement:

QUANTITY	TYPE	USED IN
1	12AT7	Oscillator
1	12AU7	Power Amplifier
1	6AK5	Pre-Amplifier
1	12AT7	Tuned Amplifier
3	6AU6	Amplifier
1	6X4	Rectifier
1	0A2	Voltage Regulator

Accessories Supplied: Short Circuit plug #477,126

Power Requirements: 105 to 125V, 50-60 cycles, 50 watts, 210 to 250 volt 50-60 cycle operation available at the extra cost of $10.00

Size: 19-1/4" wide by 10-3/4" high by 11-1/4" deep, case mounted.

Mounting: Case mounting is standard. Also available for 19 inch rack mounting at no extra cost.

Weight: Approximately 35 lbs.

SECTION II

GENERAL DESCRIPTION

2-1. General.

2-2. The Model 63A Inductance Bridge is designed to measure both the series inductance and series effective resistance of inductors over a wide range of inductance, resistance, Q value and frequency. The instrument is completely self-contained and consists of a Maxwell bridge circuit, together with a variable frequency oscillator, tuned detector, null indicator, and power supply. See Fig. 2-1.

2-3. The Maxwell bridge circuit used in the Model 63A has the advantage of direct reading of inductance and resistance at all test frequencies. As this is a non-resonant type of bridge, the accuracy of the test frequency has very little effect on the accuracy of inductance measurements. The overall inductance accuracy is dependent upon precision fixed wire wound resistors, a precision variable air capacitor, and a decade of silvered mica capacitors adjusted to an accuracy of better than $\pm$ .1%.

2-4. A somewhat novel technique* has been employed to permit coupling of the signal source and null detector amplifier to the bridge without introducing undesirable capacitance across the bridge arms. In principle, the two sides of the bridge are driven 180° out of phase by means of an extremely well balanced low impedance transformer thus permitting the bridge balance condition to be detected by coupling the null detector amplifier to the high bridge corners through two very small but well balanced coupling capacitors.

* Patent #2,607,827 issued to John H. Mennie of Boonton Electronics Corporation assigned to Western Electric Co.

2-5. Considerable care has been taken in design, layout and shielding to eliminate, minimize and compensate residual sources of error that usually limit the accuracy of precision bridges at these frequencies.

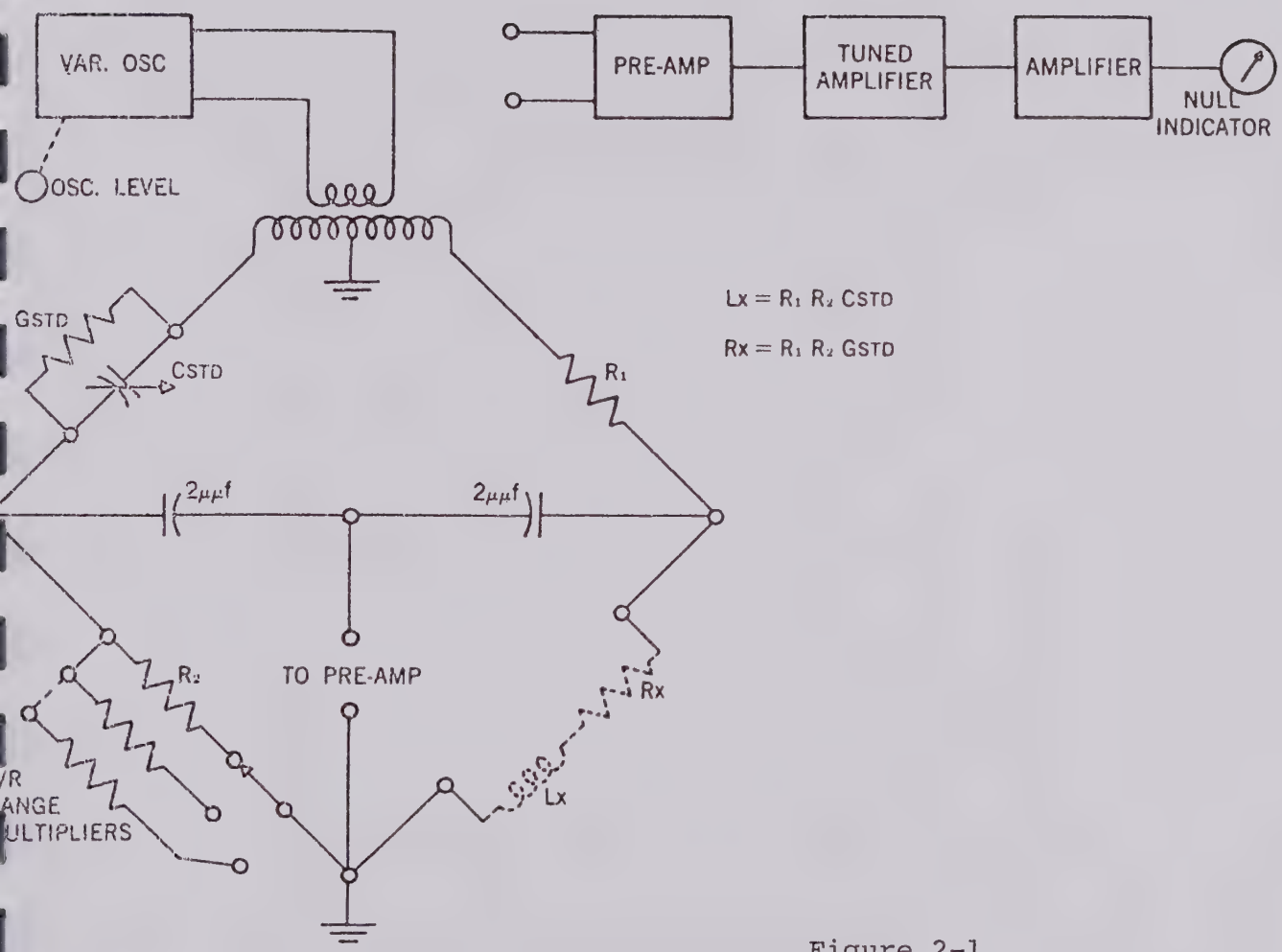


Figure 2-1

Simplified Schematic Diagram
Model 63 Inductance Bridge

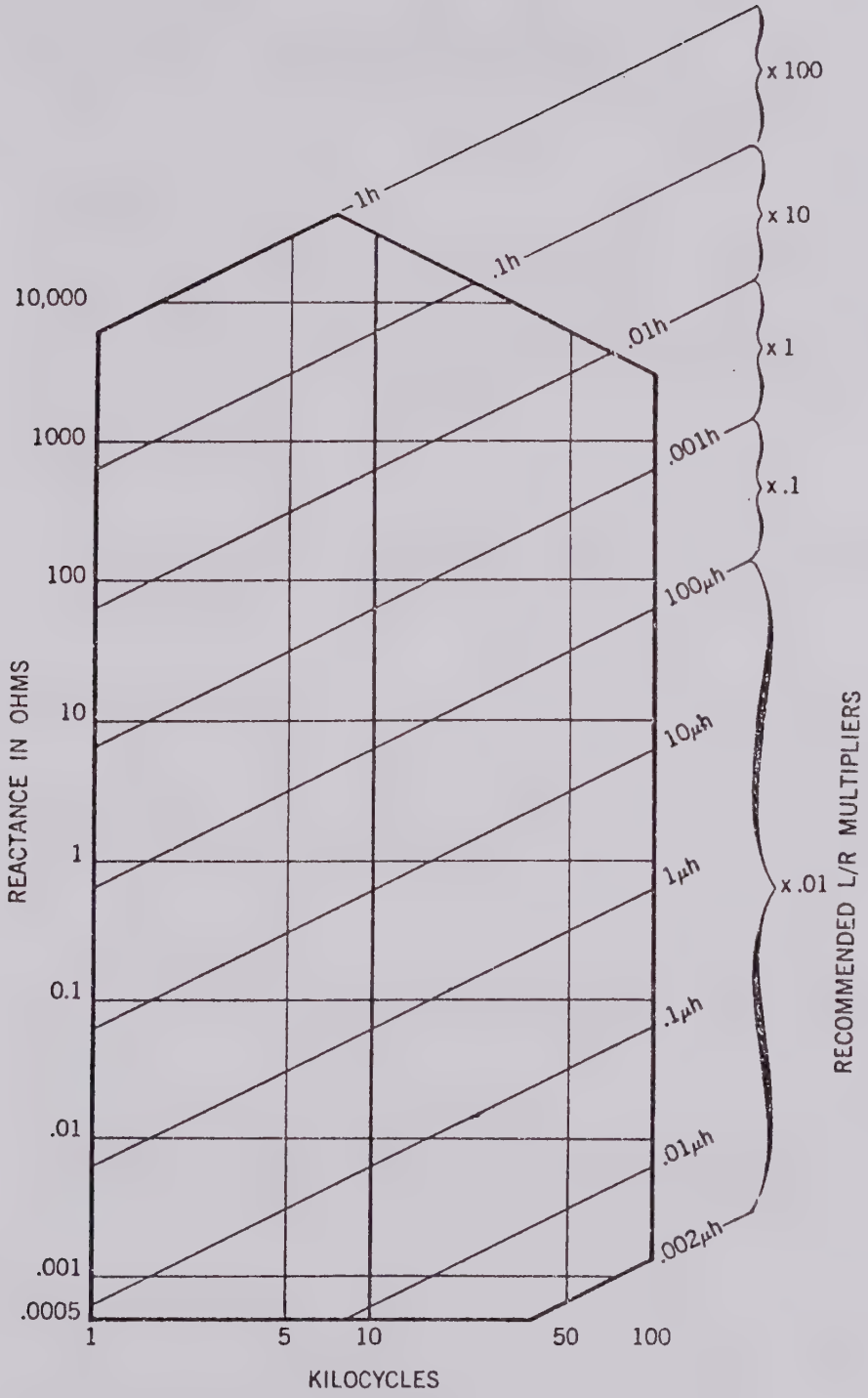


Figure 2-2

Range of Inductance Measurements
Versus Frequency - Model 63A Inductance Bridge

SECTION III

OPERATING PROCEDURE

3-1. General.

3-2. This section describes in detail the operating procedure of the Model 63A Inductance Bridge. All information required for safe and proper operation of the instrument is included. BE SURE TO READ THIS SECTION BEFORE PLACING THE INSTRUMENT INTO OPERATION!

3-3. Turn-On Procedure.

a. Before plugging the instrument into an appropriate outlet, make sure the power source is 105-125 volts a-c, 60 cycles, unless otherwise specified on nameplate.

b. Plug the instrument into the power outlet.

c. Set toggle switch to ON and allow a warm-up period of approximately two minutes. One hour warm-up may be required to achieve specified accuracy under high humidity conditions.

3-4. Measurement Procedure.

a. Connect a short circuit strap across TEST binding posts. A short circuit plug is provided with the bridge.

b. Set oscillator TEST FREQUENCY dial to desired frequency. Check Fig. 2-2 to be sure both frequency and inductance fall within boundary area shown.

c. Set MULTIPLY L/R switch to range recommended in table below for coil under test.

INDUCTANCE	MULTIPLY L and R BY
0 - 110 µh	.01
110 - 1100 µh	.1
1.1 - 11 mh	1
11 - 110 mh	10
.11 - 1.1 hy	100

d. Set both SERIES INDUCTANCE dials to read zero and both SERIES RESISTANCE dials to read zero.

e. Set OSC. LEVEL control to approximately half way (vertical) position.

f. Adjust DETECTOR TUNE control until null indicator deflection is a maximum.

g. Now alternately adjust the ZERO ADJUST (L) control and the ZERO ADJUST (R) control until the null indicator deflection is at a minimum point. Check the setting of ZERO ADJUST (L) by re-adjusting the MICROHENRIES dial and noting whether null indicator deflection is minimum when dial setting is zero. Check the setting of ZERO ADJUST (R) by re-adjusting OHMS dial and noting whether null indicator deflection is minimum when dial setting is zero.

h. Remove short circuit from across TEST binding posts and connect inductor to be tested.

i. Adjust SERIES INDUCTANCE (1000 µh) decade switch for minimum deflection of null indicator. Adjust MICROHENRIES dial to obtain a lower null indication. If null deflection is not reduced then set (1000 µh) decade switch to next lower position and re-adjust MICROHENRIES dial for minimum deflection.

j. Now adjust OHMS dial to obtain further reduction of null indication. Use (100 Ω) decade switch if necessary.

k. Now alternately adjust MICROHENRIES dial and OHMS dial until null indicator deflection is an absolute minimum.

l. To obtain the value of inductance under test, add the readings on the two SERIES INDUCTANCE dials and multiply by the factor indicated on the MULTIPLY L/R dial.

Example:

Reading on 1000 μh dial = 3000 μh
Reading on MICROHENRIES dial = 437.5 μh
Sum = 3437.5 μh
MULTIPLY L/R = .1
Inductance of coil under test = 343.75 μh

m. To obtain the value of series resistance under test, add the readings on the two SERIES RESISTANCE dials and multiply by the factor indicated on the MULTIPLY L/R dial.

Example:

Reading on 100 Ω dial = 0 Ω
Reading on OHMS dial = 64 Ω
Sum = 64 Ω
MULTIPLY L/R dial = .1
Resistance of coil under test = 6.4 Ω

3-5. AC Test Voltage and Current Measurements.

a. The a-c voltage across the coil under test or the a-c current passing through the test can be adjusted anywhere from zero to maximum by means of the OSCILLATOR LEVEL control. Maximum current available for any combination of inductance, frequency, and range is shown on curves Fig. 3-1 and Fig. 3-2.

b. The voltage appearing across the test at balance can be measured by means of a high impedance vacuum tube voltmeter.

c. The current through the test may be determined with a clip-on type a-c milliammeter such as Quan-Tech Model 301 or by measuring the voltage drop across a one ohm resistor connected between the GND terminal and the coil under test. The current in milliamperes can thus be read directly in terms of millivolts across the one ohm resistor.

3-6. Application of Superimposed DC Current

a. Superimposed d-c current may be applied to the coil under test within the maximum limits indicated in the following table.

MULTIPLY L/R RANGE	MAX. DC CURRENT Milliamperes
.01	150
.1	40
1	40
10	40
100	8

b. The d-c current source and milliammeter should be connected between the GND binding post and the low side of the coil under test. An extremely high capacitance electrolytic capacitor of adequate voltage rating should be connected across the d-c source and milliammeter to minimize errors resulting from this series impedance. This impedance may also be measured and the values subtracted from the final measurement.

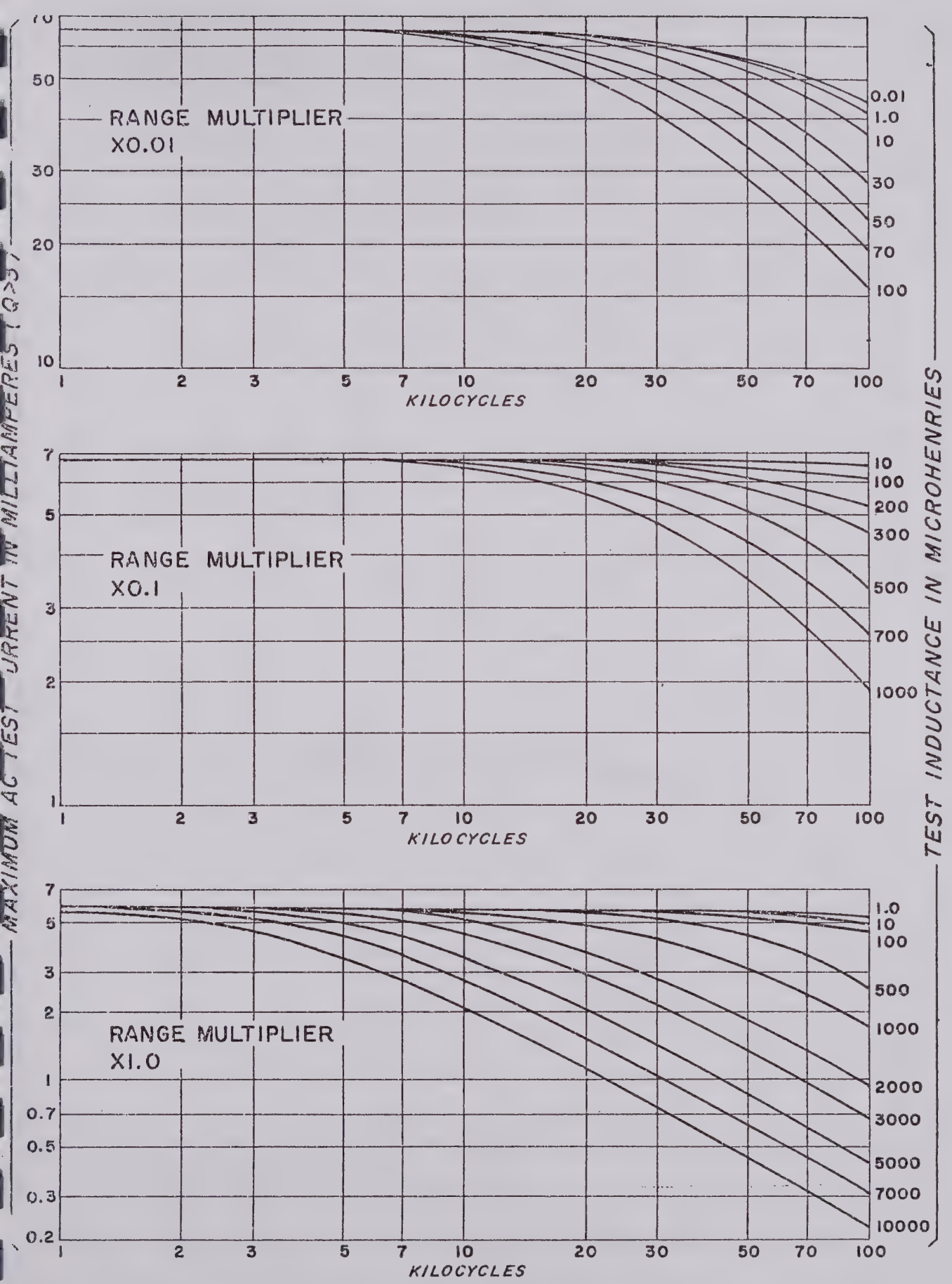
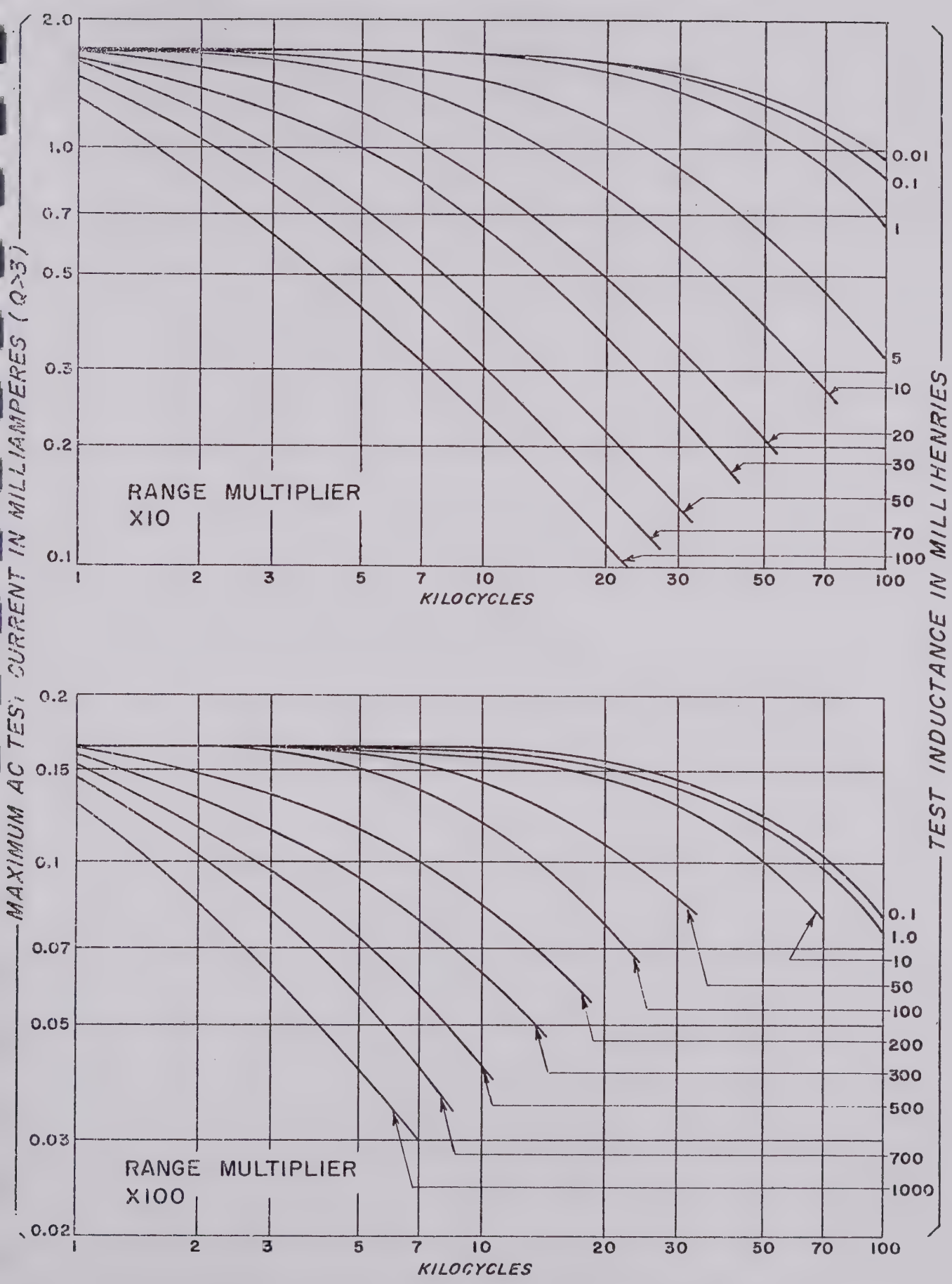


Figure 3-1 Maximum AC Test Current Versus Inductance and Frequency



re 3-2 Maximum AC Test Current Versus Inductance and Frequency (Cont'd)

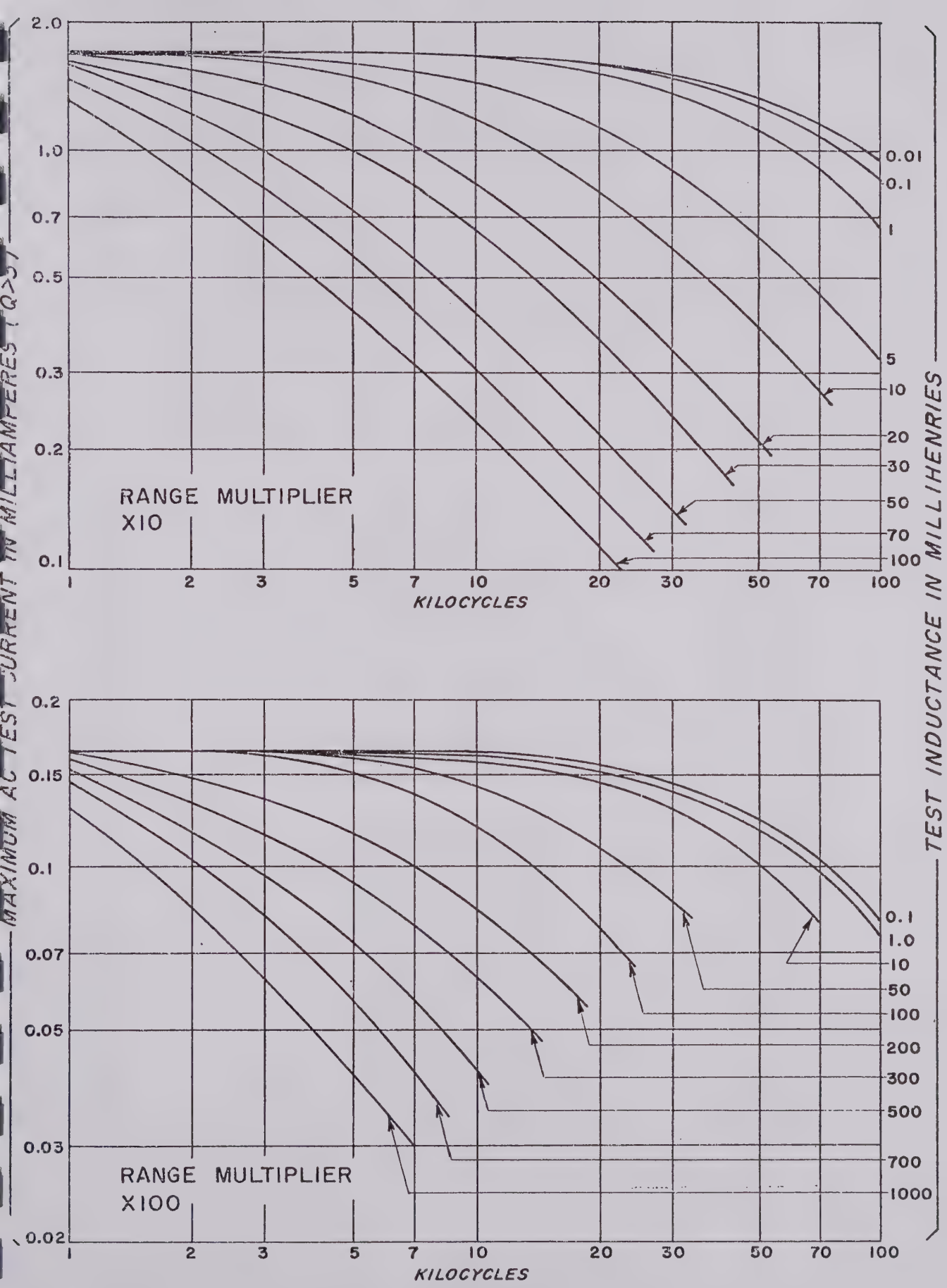


Figure 3-2 Maximum AC Test Current Versus Inductance and Frequency (Cont'd)

SECTION IV

REPLACEABLE PARTS LIST

Note:

Components in the "Bridge" section, with the exception of those in the preamplifier, have not been included, since in general their replacement must be followed by adjustments that require specialized equipment and techniques.

Reference		Description	BEC Part No.
C14	Capacitor	0.1 µf @ 200V	230,136
C21	"	90-400 µµf var.	275,501
C22	"	3150 µµf @ 500V	201,157
C23	"	270 µµf @ 500V	200,007
C24	"	14-150 µµf var.	275,500
C25	"	2700 µµf @ 500V	201,156
C26	"	90-400 µµf var.	275,501
C27	"	90-400 µµf var.	275,501
C28	"	0.1 µf @ 400V	230,124
C29	"	0.01 µf @ 300V	230,120
C30	"	0.1 µf @ 400V	230,124
C31	"	8 µf @ 350V	283,126
C32	"	0.005 @ 200V	230,121
C34	"	3-12 µµf var.	275,113
C35	"	200 µµf @ 500V	201,134
C36	"	470 µµf @ 500V	200,005
C37	"	0.01 µf @ 300V	230,120
C38	"	0.1 µf @ 400V	230,124
C39	"	0.01 µf @ 300V	230,120
C40	"	0.01 µf @ 300V	230,120
C41	"	8 µf @ 350V	283,126
C42	"	0.25 µf @ 400V	230,105
C49	"	300 µµf @ 500V	201,128
C50	"	300 µµf @ 500V	201,128
C51	"	0.1 µf @ 200V	230,116
C52	"	1.0 µf @ 200V	230,104

Reference		Description	BEC Part No.
C53	Capacitor	300 μμf @ 500V	201,128
C54	"	0.5 μf @ 200V	230,117
C55	"	0.001 μf @ 500V	201,117
C56	"	0.1 μf @ 200V	230,116
C57	"	1.0 μf @ 200V	230,104
C58	"	0.5 μf @ 200V	230,117
C59	"	0.001 μf @ 500V	201,117
C60	"	0.001 μf @ 500V	201,117
C61	"	0.1 μf @ 500V	224,111
C62	"	1.0 μf @ 200V	230,104
C69A	"	20 μf @ 450V	283,127
C69B	"	15 μf @ 450V	
C69C	"	10 μf @ 450V	
C70A	"	1000 μf @ 15V	283,114
C70B	"	1000 μf @ 15V	
D1	Diode	1N58AS	530,021
D2	"	1N58AS	530,021
F1	Fuse	1 Amp. Buss AGC-1	545,500
L16	Choke	Stancor C1707	440,001
M1	Meter	Marion Type MM-2	554,116
PL-1	Bulb	#47	545,101
Plug,	Short Circuit	General Radio #274-SB	477,126
R36	Resistor	2.2K Ω 1/2W 5%	301,095
R37	"	470K Ω 1/2W 5%	301,029
R38	"	220K Ω 1/2W 5%	301,027
R51	"	50K Ω var. (Special)	p/o 311,166
R52	"	1.5K Ω 1/2W 5%	301,091
R53	"	2K Ω var. 2W 10%	311,126
R54	"	1.5K Ω 1/2W 5%	301,091
R55	"	50K Ω var. (Special)	p/o 311,166
R56	"	47K Ω 1/2W 5%	301,127
R57	"	8.2K Ω 1/2W 5%	301,109
R58	"	8.2K Ω 1/2W 5%	301,109
R59	"	2.2 Meg. 1/2W 5%	301,167

Reference		Description			BEC Part No.
R60	Resistor	330 Ω	1/2W	5%	301,075
R61	"	15K Ω	1/2W	5%	301,115
R62	"	330 Ω	1/2W	5%	301,075
R63	"	10K Ω var.	2W	10%	311,124
R64	"	22K Ω	1/2W	5%	301,119
R70	"	500K Ω var.	2W	10%	p/o 311,140
R71	"	3K Ω	1/2W	5%	301,098
R72	"	3K Ω	1/2W	5%	301,098
R73	"	500K Ω var.	2W	10%	p/o 311,140
R74	"	1K Ω	2W	5%	304,087
R75	"	8.2K Ω	1/2W	5%	301,109
R76	"	2.2 meg.	1/2W	5%	301,167
R77	"	330 Ω	1/2W	5%	301,075
R78	"	27K Ω	1W	5%	302,135
R79	"	50K Ω var.	2W	10%	311,125
R80	"	330 Ω	1/2W	5%	301,075
R81	"	470K Ω	1/2W	5%	301,151
R82	"	100K Ω	1/2W	5%	301,135
R83	"	10K Ω	1/2W	5%	301,111
R84	"	1 Meg.	1/2W	5%	301,159
R85	"	620 Ω	1/2W	5%	301,082
R86	"	15K Ω	2W	5%	304,061
R87	"	470K Ω	1/2W	10%	301,029
R92	"	470K Ω	1/2W	10%	301,029
R93	"	470K Ω	1/2W	10%	301,029
R94	"	33K Ω	1/2W	5%	301,123
R95	"	47K Ω	1/2W	5%	301,127
R96	"	1K Ω	1/2W	5%	301,087
R97	"	50K Ω var.	1/10W		311,120
R98	"	3.3K Ω	1/2W	5%	301,099
R99	"	220K Ω	1/2W	10%	301,027
R100	"	470K Ω	1/2W	10%	301,029
R101	"	1 Meg.	1/2W	5%	301,159
R102	"	470K Ω	1/2W	10%	301,029
R103	"	47K Ω	1/2W	5%	301,127
R104	"	220K Ω	1/2W	10%	301,027
R105	"	470K Ω	1/2W	10%	301,029
R106	"	1 Meg.	1/2W	5%	301,159
R107	"	100K Ω	1W	5%	302,149
R108	"	470 Ω	1/2W	5%	301,079
R109	"	47K Ω	1/2W	5%	301,127

Reference		Description			BEC Part No.
R110	Resistor	47K Ω	1/2W	5%	301,127
R111	"	500 Ω var.	1/10W		311,118
R112	"	330 Ω	1/2W	10%	301,010
R113	"	470K Ω	1/2W	10%	301,029
R114	"	470K Ω	1/2W	10%	301,029
R115	"	220K Ω	1/2W	10%	301,027
R119	"	150 Ω	1W	10%	302,008
R120	"	150 Ω	1W	10%	302,008
R121	"	7.5K Ω	10W	10%	312,100
R122	"	47 Ω	2W	5%	304,055
SR1	Selenium Rectifier	Sarkes-Tarzian #304B			532,001
S5	Switch	4P2T CRL PS-113			466,128
S6	"	DPST Carling 216-62			465,100
T2	Transformer	Stancor PC8408			446,013
TH-1	Thermistor	VECO 65A-1			325,001
V1	Tube	12AT7			526,12AT7
V2	"	12AU7			526,12AU7
V3	"	6AK5			526,6AK5
V4	"	12AT7			526,12AT7
V5	"	6AU6			526,6AU6
V6	"	6AU6			526,6AU6
V7	"	6AU6			526,6AU6
V8	"	6X4			526,6X4
V9	"	0A2			526,0A2

SECTION V

SHIPPING INSTRUCTIONS

5-1. If it becomes necessary to ship the instrument for any reason, wrap the unit with heavy wrapping paper and seal the seams with gummed tape. Place the instrument into a fibreboard carton large enough to allow at least three inches of soft packing material to be placed between the instrument and the sides of the box.

WARRANTY

BOONTON ELECTRONICS CORPORATION guarantees to the original purchaser that each instrument it manufactures be free from defects in material and workmanship for a period of one year after date of initial shipment. Our liability is limited to repairing or replacing any defective part with the exception of vacuum tubes, panel lamps, fuses, and batteries. The warranty lapses if, upon our examination, we judge that the instrument has been abused in any way.

PROCEDURE TO FOLLOW WHEN INSTRUMENT IS DEFECTIVE

1. Call our plant or our representative nearest you. A simple solution may result from discussion of the problem with our trained personnel.

2. If the fault is not readily eliminated, prepare the instrument for return to us. Pack carefully in a sturdy container using several inches of shock absorbing material on all six sides of the instrument. Include all probes, cables or accessory units. On all paper work pertaining to the returned instrument, note the model and serial number and state briefly the details of the fault. Ship to us transportation charges prepaid.

3. If the instrument is within the warranty, we will repair and return to you transportation charges prepaid. If the instrument is beyond the one year warranty period, we will repair and return it unless approval on a cost estimate is requested. If the instrument is within the one year warranty period, but our examination reveals abuse, we will await approval of our cost estimate before proceeding with repairs.

63A INDUCTANCE BRIDGE

CALIBRATION PROCEDURE

BOONTON ELECTRONICS CORPORATION

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ROUTE 287 AT SMITH ROAD
PARSIPPANY, N. J.— 07054

63A INDUCTANCE BRIDGE

CALIBRATION PROCEDURE

AMENDMENT #1

Reference II. 3 BALANCE CAPACITOR ADJUSTMENT

When this adjustment is made the test terminals must be open.

Reference II. 4 RESISTANCE DIAL CALIBRATION (R1)

Paragraph II 4.1 When the resistance dial is rotated counterclockwise and the open position of the control is reached, which is indicated by a sudden drop in the meter reading, the rotation should be stopped and the resistance zero control adjusted for a null. If this is not done, as the control is rotated through the flat, another drop in the meter reading will be noted. This indication is variable depending on the setting of the zero control. When the meter deflection starts to rise rapidly then the resistance zero control should again be adjusted for a null.

When the initial calibration of the resistance dial is made, the marking fiducial should be replaced with the indicating fiducial, with the resistance dial at exactly 100 ohms. If the fiducial is replaced at zero ohms an error of several per cent could be noted at 100 ohms.

63A INDUCTANCE BRIDGE CALIBRATION PROCEDURE

The following procedure covers the complete calibration of the bridge. It may be used as a basis for production calibration of new instruments or by anyone repairing or desiring to check any particular section of the instrument.

This procedure may be divided into two main groups:

I. The adjustment of circuits not directly connected with the bridge accuracy but necessary for its proper operation.

II. Adjustment of circuits that are necessary to obtain the basic measuring accuracy of the bridge.

I 1.0 The first operation of group one would be the calibration of the "Test" oscillator frequency dial. Reference should be made here to schematic 830028 for identification of controls and adjustments. The extreme ends of the frequency range that is 1 and 100 Kc should be set to be approximately equal distance from the end of rotation. The changing of the values of resistors R71 and R72 will shift the position of the 100 Kc end. The low end (1 Kc) may be changed by the value of capacitor C36. These adjustments will extend or shorten the band width and the values given on the schematic are nominal. To shift the band width, adjust trimmer #10 (C34) on the top of the chassis. After this is accomplished the dial may be calibrated for all frequencies using an accurate frequency counter or meter. The output voltage level from the oscillator amplifier combination may be measured at J1

and should be approximately 40 to 45 volts rms over the entire frequency range.

I 2.1 The second operation of group one is the alignment of the tuned detector. This may be done by using a separate oscillator fed into P1. Disconnect coaxial cable P1 from J1. Turn bridge oscillator level to minimum. Connect an oscillator such as a Hewlett Packard 200 CD, (output frequency 1 to 200 Kc output level approximately 20 volts rms) to P1. Connect a vacuum tube voltmeter such as a Ballantine 314 at J2. This may be connected in by a "T" connection. Do not disconnect J2 from P2. Set detector range to the low position (1 to 10 Kc) and by carefully adjusting controls marked 6, 7, 8 and 22 tune for complete coverage of the frequency range of 1 to 10 Kc with no oscillation. Check the discrimination by setting the oscillator to 1 Kc and peaking detector, note Ballantine reading, reset oscillator to 2 Kc leaving detector tuning set and again noting reading on the Ballantine. The difference in the two readings in db is the amount of discrimination and should be at least 20 db minimum over the frequency range. The maximum may go as high as 30 db without signs of oscillation but should never be less than 20 db for good sensitivity of the bridge.

I 2.2 Repeat the above procedure on the detector range of from 10 to 100 Kc using adjustments 9 and 23. It should not be necessary to readjust 6 and 7 on this range. However if it is not possible

to keep the circuit from oscillating, it may be necessary to readjust 6 and 7. In this case it will be necessary to go back and recheck the range of from 1 to 10 Kc.

I 2.3 The adjustments referred to above are located as follows: 6 and 7 are potentiometers on top of the oscillator-detector chassis. 8, 9, 22 and 23 are trimmer capacitors located to the front of the detector circuit card and adjustable from the bottom of the bridge.

I 2.4 When this operation is completed the detector should tune all frequencies from 1 to 100 Kc with no signs of oscillation and a minimum discrimination of 20 db. During this procedure the signal level used from the external oscillator should be kept as low as possible to obtain satisfactory results and not to overload the preamplifier.

This completes the group one adjustments.

II The group two adjustments are all ones affecting the basic measuring accuracy of the bridge. They should be performed with utmost care and precision as the final result will be affected by each of these. This group may be divided into six separate operations and should be performed in the following sequence. Refer to schematic 830027.

II 1.0 Calibration of the inductance dial, variable capacitor C1 and the inductance decade switch S3.

II 2.0 Product arm adjustment.

II 3.0 Balance capacitor adjustment C13.

II 4.0 Resistance dial calibration R1.

II 5.0 Adjustment of zeroing components.

II 6.0 Final calibration with known inductance standards.

II 1.0 Calibration of The Inductance Dial and Inductance Decade Switch

II 1.1 The variable inductance dial is an extremely accurate air capacitor, while the decade inductance switch is made up of precision silver mica capacitors shunted by low value stable trimmers for exact adjustment. The total inductance dial and each step of the decade switch are in 500 pf steps. Each 100 μh division on the inductance dial represents 50 pf. Their accuracy is of prime importance to the calibration of the inductance measurements

II 1.2 Refer to the bridge section schematic 830,027 while doing the following operations.

II 1.3 Open the circuit at L1 which is the wire braid to the ceramic standoff in the bridge section.

II 1.4 Open the circuit at B by removing the lead at the transformer (T1) terminal.

II 1.5 Open the circuit at R2 (14K Vamistor located below the air capacitor).

II 1.6 Open the circuit of the R and L zero controls to the air capacitor C1, these are the two leads to the rotor of the air

capacitor.

II 1.7 Set the inductance dial and inductance decade switch to zero.

II 1.8 Connect a three terminal capacitance bridge with a guaranteed accuracy of ±0.1% at a test frequency of 20 Kc, as follows: the High point to the rotor of switch S2A, the Low point to the bridge section sub-panel. Also connect both the inductance bridge chassis and the capacitance bridge chassis together.

II 1.9 Care must be taken to use leads of minimum length, approximately 24 inches, between the capacitance bridge and the unit under test. A capacitance bridge using a test frequency of higher than 20 Kc may result in errors due to lead length, especially at the higher values of capacity.

II 1.10 Balance out all residual capacitance and resistance on the capacitance bridge.

II 1.11 Read the value of each consecutive step on the decade inductance switch, each step is a change of 500 pf and should be within ±0.1%, if not, adjustments may be made as follows. (Refer to paragraph 18 for location of adjustments.)

II 1.12 The 1,000 μh position, the capacity should be 500 pf and may be adjusted by C10.

II 1.13 The 2,000 μh position, the capacity should be 1,000 pf and may be adjusted by C4.

II 1.14 The 3,000 µh position, the capacity should be 1,500 pf and may be adjusted by C3. On this position the 1,500 pf is the combination of the two capacitors of the first two positions. If an error is inducated on this position read the value of error capacitance then reset the capacitance bridge to zero and then offset it by the amount of error but in the opposite direction. For example, if this position read 3 pf too high, offset the capacitance bridge 3 pf low from the zero position and adjust C3 for a balance. Return the capacitance bridge to zero, rebalance and check the first three positions again. Repeat the above procedure until all three steps are within ±0.1% of their nominal value.

II 1.15 The 4,000 µh position, the capacity should be 2,000 pf and may be adjusted by C6.

II 1.16 The 5,000 µh position, the capacity should be 2,500 pf and may be adjusted by C8.

II 1.17 Check all remaining positions of the decade inductance switch which should now be within the prescribed tolerance since they are made up of combinations of capacitors all ready adjusted.

II 1.18 For purposes of adjustment the capacitors are as follows when viewing the inductance switch from the rear, the right side near the top is C10 then following on a clockwise direction C4, C8 and C6. C3 is directly across the switch contacts.

This completes the checking of the inductance decade switch.

II 1.19 Now check the inductance dial (air capacitor) every 100 µh, which is a change of 50 pf starting from zero, for a total of 500 pf. Errors in the air capacitor can only be corrected by bending the outside slotted rotor plates. This adjustment is extremely critical and great care should be taken, as the final inductance readings will depend on this accuracy.

II 1.20 Restore all connections to normal except the lead at "B" to transformer T1 which should be left open.

II 2.0 Product Arm Adjustment.

II 2.1 The adjustment of the product arm of the bridge is made on a d.c. resistance measurement basis. A resistance bridge accurate to five places is required (0.0000). Three leads are required on the resistance bridge and should all be the same length. Their resistance should be measured and used in the adjustment calculation. One lead should connect the ground side of the resistance bridge to the ground side of the inductance bridge at "D". The other two leads one we call "A" should be connected to the left terminal of the balance capacitor C13, the other lead we shall call "C" will be connected to the right terminal of the balance capacitor C13. Remove any shorting plug or strap across the bridge test terminals. Referring to schematic 830027, it will be noted that we can measure the resistance C to D with our lead we previously called "C", also by replacing lead "C" with lead "A"

on the resistance bridge we can measure the resistance from A to D. The product of the two resistances that is A to D and C to D is given in the table below.

L-R MULTIPLY SWITCH	PRODUCT
X100	2×10^8
X10	2×10^7
X1.0	2×10^6
X0.1	2×10^5
X0.01	2×10^4

II 2.2 Now set the L-R multiply switch to the 0.01 position and measure the resistance from A to D. Subtract from this value the resistance of the leads. Divide 2×10^4 by this value and the result plus the lead resistance will be the amount we must adjust R22 adjustment 1 to. Connecting the bridge resistance from C to D we adjust R22, to this value.

II 2.3 Next set the L-R multiply switch to the 0.1 position and using the corrected value previously obtained from A to D, divide 2×10^5 by this amount to obtain the resistance that will be adjusted to by R19, adjustment 2, and measured from C to D.

II 2.4 Set the L-R multiply switch to the X1 position and measure the resistance from C to D. Correct this value for lead resistance and divide 2×10^6 by it. The value obtained will be adjusted to by R33 adjustment three and measured from A to D.

II 2.5 Set the L-R multiply switch to the X10 position and measure the resistance from C to D, correct for lead resistance and divide 2×10^7 by this value. Adjust R35 adjustment four to this value, as measured from A to D.

II 2.6 Set the L-R multiply switch to the X100 position and using the corrected value obtained on the X10 position from A to D divide 2×10^8 by this value to obtain the resistance that R16 adjustment five will be set to and measured from C to D.

II 2.7 This completes the adjustment of the product arm. Several precautions must be taken here to obtain accurate results. The lead resistance must be taken into account on all measurements, especially the low values of resistance. One further note is that all readings referred to as from C to D on the schematic are actually from C through the transformer secondary at B to ground D. The test terminals of the bridge must be opened for this adjustment.

Restore the lead at B to the transformer T1.

II 3.0 Balance Capacitor Adjustment (C13).

II 3.1 Open the circuit at point "D" to the L-R multiply switch, this is a braid lead from the bridge chassis to the rear of this switch S1. Short the rotor of the variable capacitor C1 to the stator section. With the bridge operating at 10 Kc (detector tuned) set the L-R multiply switch to the X0.01 position. Adjust each of the screws on the balance capacitor C13 until a null is indicated

on the meter. Adjust for a minimum null which will not be zero on the meter.

II 4.0 Resistance Dial Calibration (R1).

II 4.1 With the bridge operating at 10 Kc (detector tuned), set the L-R multiply switch to the X1.0 position. Connect a decade resistance box (General Radio 1432T) with as short leads as possible to the bridge test terminals. Set all steps of the resistance box to zero. Set oscillator level for approximately one half scale meter deflection. Rotate resistance dial slowly counter-clockwise, keeping the meter close to a null with the inductance dial. The resistance dial has no stop position and the rotation should be continued until the open position of the control is reached which will be indicated by a sudden drop in the meter deflection. Continue to rotate dial through this flat portion until the deflection starts to rise rapidly. Stop rotation and adjust for a null with the resistance zero control and inductance control. Set the decade resistance box to 0.2 ohms and rotate resistance dial only for a null. Mark the dial at this point as zero. Remove the 0.2 ohms on the decade resistance box and rezero by the resistance zero control. Set inductance zero control at mid rotation, set the inductance dial to zero and adjust L9 adjustment 13 for a null. Set the decade resistance box to 100 ohms and rotate resistance dial for a null. Mark the dial at this

point for 100. Set the inductance dial at minus three divisions (μh) below zero and adjust L5 adjustment 17 for a null. The remaining points of the dial may now be marked.

II 4.2 For checking the resistance dial of a bridge that has the dial all ready marked, it is only necessary to verify the dial readings against a known standard decade resistance box.

II 5.0 Adjustment of Zeroing Controls.

II 5.1 In the initial calibration of the inductance bridge the ability to zero the bridge at all useable frequencies on all positions of the L-R multiplier switch must be checked. The nominal values of resistors R41, R42 and R43 are such that they should require no further adjustment for proper zeroing of the resistance control on the positions of X1, X10 and X100 of the L-R multiply switch. However, L9, L10 and L11 which are adjustments 13. 14 and 15 may be adjusted for bringing the inductance zeroing control within its range on these three positions.

II 5.2 On the X0.01 and X0.1 ranges R39 and R40 are made up of resistance wire to obtain the proper zeroing adjustment for resistance. They should be made as low as possible in inductance so L7 and L8 adjustments 11 and 12 may bring the inductance control within its range on all frequencies. These adjustments should be made to insure the bridge can be zeroed on all frequencies and on all positions of the L-R multiply switch. In some cases it

may not be possible to null the bridge to zero in that portion of the frequency range which is beyond the recommended settings shown on figure 2 of the 63A instruction book.

II 5.3 Adjustments of any of the above-mentioned components will not affect the bridge measuring accuracy, if the bridge can be nulled to zero.

II 6.0 Final Calibration with Known Inductance Standards.

II 6.1 This is the final calibration of the bridge and requires the most time and care in adjustment. Before attempting the final calibration the bridge should have a minimum warm-up time in its case of at least two hours and if it has been subject to high relative humidity conditions, a 24 hour warm-up time should be given. This final calibration requires the use of standards of inductance that have been verified for both inductance and series resistance at frequencies from 1 to 100 Kc and several values of inductance. Typical inductances and the frequency requirements are given below, for use in calibration of a 63A inductance bridge.

Inductance Value	Frequencies for which the Standard Inductance and Resistance Values Must be Known	
100 μh	10 Kc	100 Kc
1 MH	10 Kc	100 Kc
10 MH	10 Kc	60 Kc
100 MH	5 Kc	20 Kc
1 H	1 Kc	4.5 Kc

The above inductances are preferred to be of the General Radio type 1482 which have been verified at the given frequencies.

II 6.2 Beginning with the L-R multiply switch on the X10 position and the bridge operating at 5 Kc, the accuracy may be checked with the 100 MH inductance standard. If care was used in the adjustment of the product arm the inductance and series resistance value should be within the prescribed tolerances at this frequency. If not adjustment 4 (R35) may be adjusted for the correct inductance value. The next step would be to check the 10 MH standard at 10 Kc, for which adjustment 4 (R35) is also used. It should be set for the closest reading to the standard for both values of inductance at the two frequencies. The next check point would be the 100 MH standard at 20 Kc. Here the balance capacitor C13 may be adjusted to give the correct value of series resistance at this frequency. This value should be close to nominal if the balance capacitor was properly adjusted as in step 3. If it is not close to nominal the 10 MH standard should be checked at 60 Kc for its series resistance reading which may be adjusted by L4 adjustment 18. This will also have considerable effect on the series resistance reading of the 100 MH standard at 20 Kc which should now be rechecked. After alternately checking these two standards the entire set of check points should be carefully

rechecked on this setting of the L-R multiply switch. Caution should be observed here in setting the frequency for each check, a frequency counter should be used and the frequency should be with ±0.1% of the frequency for which the standard is verified.

II 6.3 The inductance of L1 and L2 determine the accuracy of inductance at the higher frequency and the original value of these inductances should be satisfactory if all other adjustments are made as given here. After completing the X10 range, the L-R multiply switch should be set to the X0.01 position.

II 6.4 The 100 μh standard should be checked at 10 Kc and, if necessary, adjustment 1 (R22) should be made for inductance. Next the 100 μh standard should be checked at 100 Kc and adjustment made by 20 (C12) for correct series resistance.

II 6.5 The next setting of the L-R multiplier switch is the X0.1 position. A check should be made of the 100 μh and 1 MH standards at 10 Kc. If necessary, adjustment can be made for inductance by 2 (R19). Next the 100 μh and 1 MH standards can be checked at 100 Kc and 16 (L6) can be adjusted for correct series resistance reading.

II 6.6 The next position of the L-R multiplier switch is the X1.0 position. The 1 MH and 10 MH standards can be checked at 10 Kc and adjustment made by 3 (R33) for correct inductance reading.

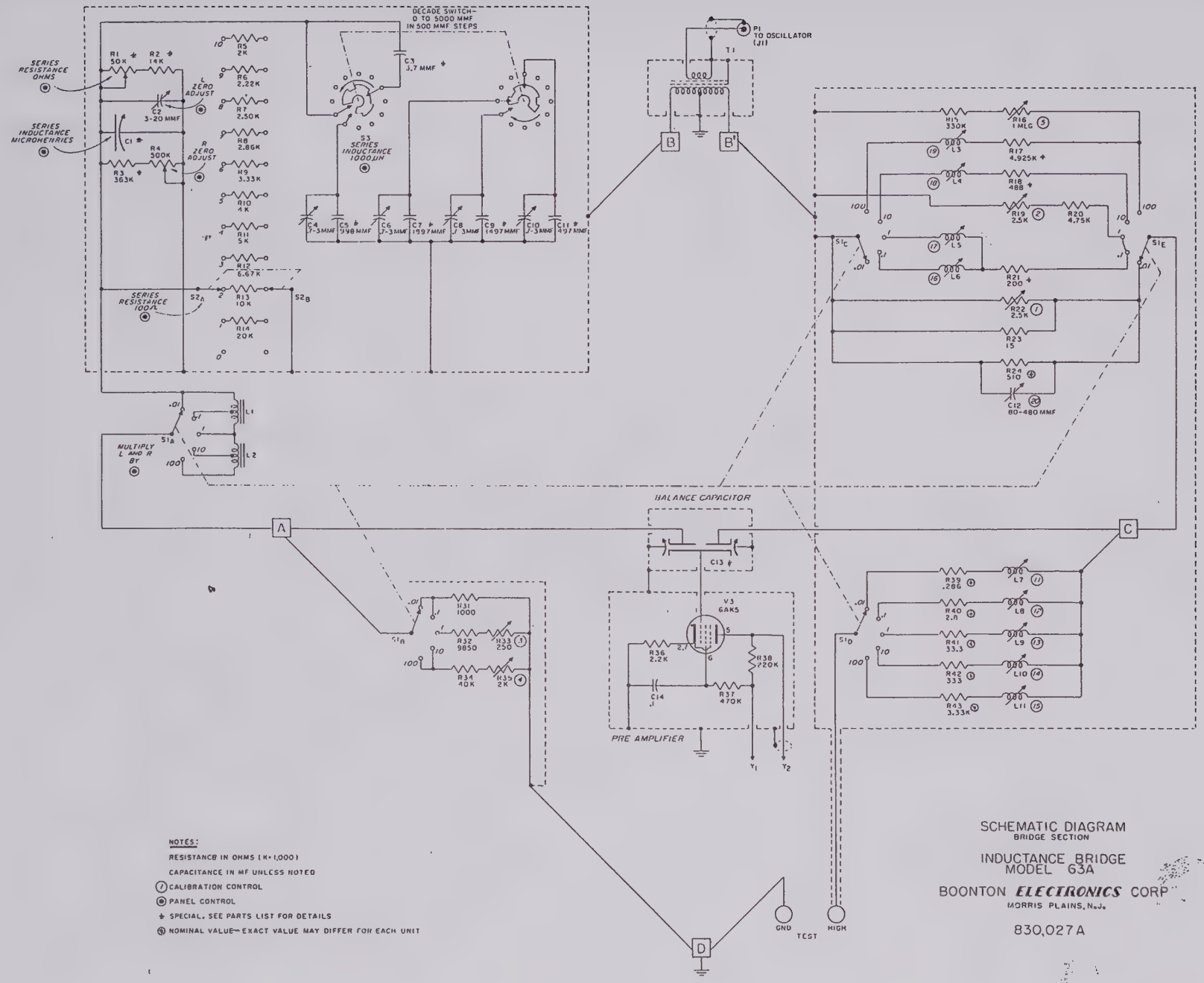
The 10 MH standard can be checked at 60 Kc and the 1MH at 100 Kc, and adjustment 17 (L5) can be set for correct series resistance reading.

II 6.7 The X10 setting of the L-R multiply switch should be rechecked at this time.

II 6.8 Next the L-R multiply switch should be set to the X100 position. The 1 henry and 100 MH standards should be checked at 1 Kc, as well as the 1 henry at 4.5 Kc. Adjustment may be made for inductance by 5 (R16). The 100 MH standard should be checked at 20 Kc and adjustment 19 (13) made for series resistance.

II 6.9 This completes the calibration with the standards for inductance and series resistance. A complete run through the readings for all standards should be made again at this time to insure that proper adjustment has been made.

II 7.0 During this calibration the frequency at which the inductances have been standardized at, must be maintained within 0.1%. Also the standards must be connected to the bridge with uniform and short connections in order not to introduce errors. If standards of inductance and series resistance are not available for these frequencies, an attempt to calibrate the bridge should not be made.



NOTES:

RESISTANCE IN OHMS (K=1,000)

CAPACITANCE IN MF UNLESS NOTED

(/) CALIBRATION CONTROL

(⊙) PANEL CONTROL

★ SPECIAL, SEE PARTS LIST FOR DETAILS

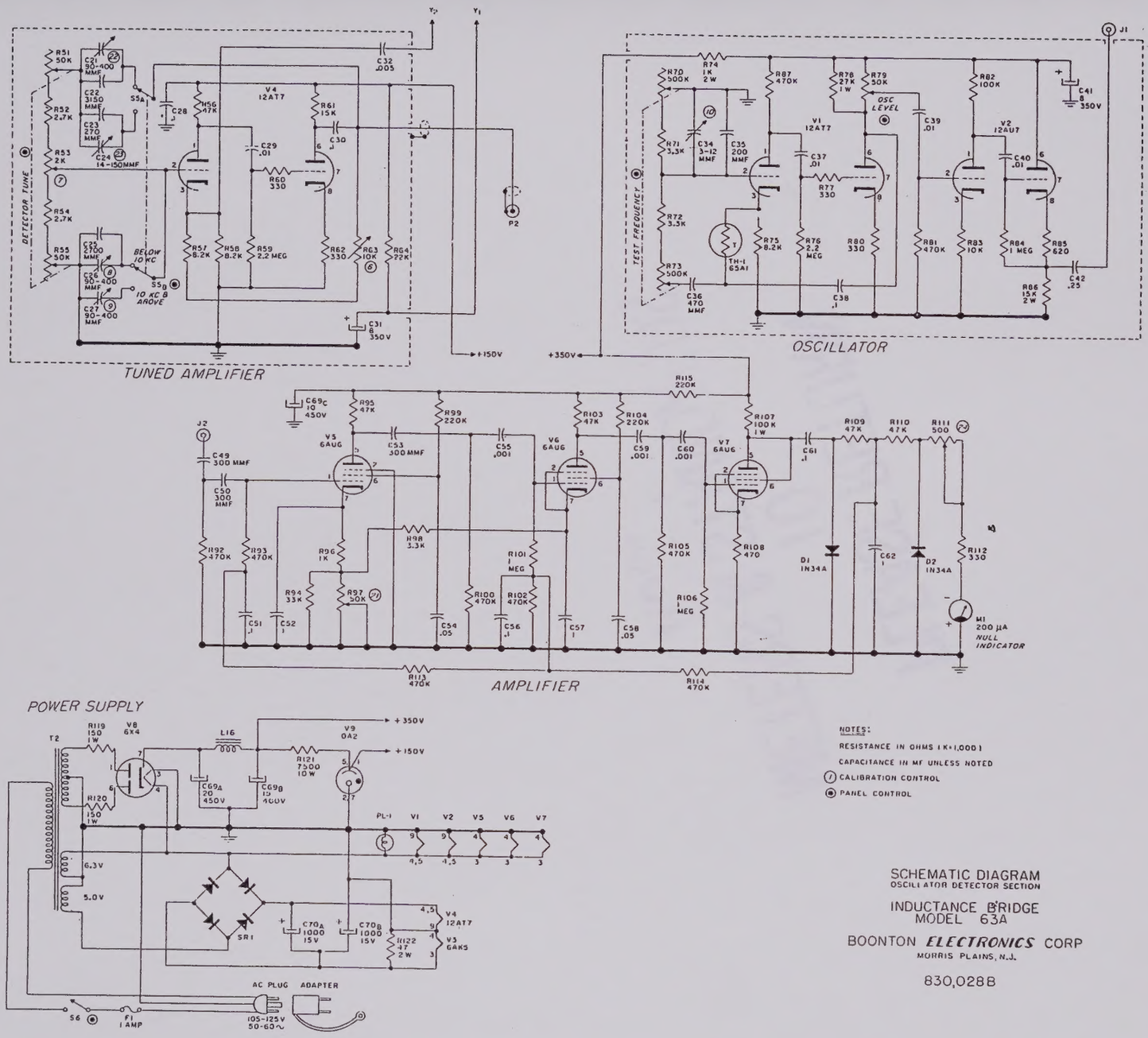
Ⓝ NOMINAL VALUE— EXACT VALUE MAY DIFFER FOR EACH UNIT

SCHEMATIC DIAGRAM
BRIDGE SECTION

INDUCTANCE BRIDGE
MODEL 63A

BOONTON ELECTRONICS CORP.
MORRIS PLAINS, N.J.

830,027A



NOTES:

RESISTANCE IN OHMS (K=1,000)

CAPACITANCE IN MF UNLESS NOTED

(/) CALIBRATION CONTROL

(●) PANEL CONTROL

SCHEMATIC DIAGRAM
OSCILLATOR DETECTOR SECTION

INDUCTANCE BRIDGE
MODEL 63A

BOONTON ELECTRONICS CORP
MORRIS PLAINS, N.J.

830,0288

PLEASE RETURN
TO
METERS & STANDARDS
ROOM

MP MASTER
MA24714